

# Technical Design Report

## Roman Pot Detectors for Small Angle $pp$ Scattering

April, 1998

Technical Design Report Roman Pot Detectors for Small Angle $pp$ Scattering .....	1
<b>I Physics Goals .....</b>	<b>4</b>
<b>1 Overview .....</b>	<b>4</b>
1.1 Introduction .....	4
<b>2 Elastic Scattering at Small <math> t </math>.....</b>	<b>4</b>
2.1 Previous Experiments .....	4
2.2 Theoretical Interest and Models .....	4
2.3 Polarization in the CNI Region .....	4
2.4 Experimentation with $pp$ at RHIC.....	4
2.4.1 Machine Operation .....	4
2.4.2 Simulations.....	4
2.4.3 Polarimeter Function.....	4
2.4.4 Luminosity and Rates.....	4
<b>3 Elastic Scattering at Medium <math> t </math>.....</b>	<b>4</b>
3.1 Theoretical Interest and Models .....	4
3.2 Polarization at Medium $ t $ .....	5
3.3 Previous Experiments .....	5
3.4 Experimentation with $pp$ at RHIC.....	5
3.4.1 Machine Operation .....	5
3.4.2 Simulations.....	5
3.4.3 Backgrounds, Rates, and Luminosity.....	5
<b>II Detectors .....</b>	<b>6</b>
<b>1 Introduction .....</b>	<b>6</b>
<b>2 Roman Pot System .....</b>	<b>6</b>
2.1 Machine Environment .....	6
2.1.1 Expected Signal Rates, Backgrounds, and Radiation .....	6
2.1.2 Requirements by the Accelerator .....	6
2.1.3 Vacuum Techniques and Materials.....	6
2.1.4 Beam-Induced RF in Detectors.....	6
2.2 Detector Requirements .....	6
2.3 Detector Positioning.....	6
2.3.1 Local Position Determination .....	6
2.3.2 Global Positioning in the Accelerator .....	6
2.3.3 On-line Position Monitoring .....	6
2.4 RP Vacuum System.....	6
2.4.1 Description of System .....	6
2.4.2 Failure Modes and Protection .....	6
<b>3 Silicon Detectors .....</b>	<b>7</b>
3.1 Motivation and Requirements .....	7
3.1.1 Accuracy Requirements.....	7
3.1.2 Rate requirements .....	7
3.1.3 Radiation Hardness .....	7
3.2 Strip Detectors .....	7

3.2.1	Layout.....	7
3.2.2	Strip Detector Performance .....	7
3.2.3	Detector Supports.....	7
3.2.4	Position Accuracy .....	7
3.2.5	Specifications.....	7
3.2.6	Bench Tests and Acceptance Criteria .....	7
3.3	SVX Read-out.....	7
3.3.1	Specifications, Timings, and Operation.....	7
3.3.2	Board Layout .....	7
3.3.3	Tests .....	7
<b>4</b>	<b>RP Trigger Detector .....</b>	<b>7</b>
4.1	Trigger Strategy.....	8
4.2	Requirements.....	8
4.2.1	Rates and Deadtime .....	8
4.2.2	Radiation Hardness .....	8
4.3	Design .....	8
4.3.1	Mechanical Layout .....	8
4.3.2	Lightguides.....	8
4.3.3	Photodetectors.....	8
4.4	Trigger .....	8
4.4.1	Trigger Electronics .....	8
4.4.2	Trigger Control.....	8
4.4.3	.....	8
4.4.4	.....	8
<b>5</b>	<b>Detector Package .....</b>	<b>8</b>
5.1	Trigger and Tracking Block.....	9
5.1.1	Design .....	9
5.1.2	Detector Platform Mounts .....	9
5.1.3	Vacuum and Leak Considerations .....	9
5.2	Package Positioning .....	9
5.2.1	In-Vacuum Accuracy .....	9
<b>6</b>	<b>Central Region Detector .....</b>	<b>9</b>
6.1	Function of a Central Detector .....	9
6.2	CD Design Parameters.....	9
6.3	Connections to Brahms at Medium $ t $ .....	9
6.3.1	Trigger Feeds from and to Brahms .....	9
6.3.2	Common Data Stream.....	9
<b>7</b>	<b>Data Acquisition .....</b>	<b>9</b>
7.1	Overview and Philosophy.....	10
7.2	Read-out .....	10
7.2.1	SVX Read-out Board.....	10
7.2.2	Interface and Port Card .....	10
7.2.3	VME Front-End Buffer Board.....	10
7.3	SVX and VFB Control.....	10
7.4	On-line Computer .....	10
7.4.1	Data Transfer Control .....	10
7.4.2	On-line Preprocessing .....	10
7.4.3	On-line Data Monitoring and Fault Detection .....	10
7.5	Pulseheight Calibrations .....	10
7.5.1	Trigger Calibration .....	10
7.5.2	Silicon Detector Calibrations.....	10
<b>8</b>	<b>Detector Position Control and Monitoring.....</b>	<b>10</b>
8.1	Pot Position Control .....	10

8.1.1	Pot Position Read-out .....	10
8.1.2	Detector Position Read-out .....	10
8.1.3	Failsafes.....	10
8.2	Beam Position Monitoring .....	10
<b>9</b>	<b>Rate Monitoring .....</b>	<b>10</b>
9.1	Rate Monitoring.....	10
9.1.1	Maximum Allowable Rates and Protection Mechanisms.....	11
<b>10</b>	<b>Data Analysis .....</b>	<b>11</b>
10.1	Data Streams .....	12
10.2	Data Storage .....	12
10.3	Data Base.....	12
10.3.1	Run Parameters.....	12
10.3.2	Machine Parameters.....	12
10.4	Reconstruction .....	12
10.4.1	Trajectory Tracing from IP to RP .....	12
10.4.2	Small $ t $ Data .....	12
10.4.3	Medium $ t $ Data.....	12
10.5	Systematics.....	12
10.5.1	Detector Position Calibration .....	12
10.5.2	Calibration of $ t $ -Scale.....	12
10.5.3	Acceptance and Efficiency Determination .....	12
10.5.4	Determination of Backgrounds .....	12
10.5.5	Systematics in the Analyzing Power $A_N$ .....	12
<b>11</b>	<b>Prototypes and Tests.....</b>	<b>12</b>
11.1	1998 Beam Test .....	12
11.1.1	Prototype Roman Pot System.....	12
11.1.2	Prototype Silicon Detector.....	12
11.1.3	Prototype Trigger and Detector Block.....	12
11.1.4	Prototype Readout System .....	12
11.2	Further Prototypes.....	13
<b>III</b>	<b>RHIC Run Requests .....</b>	<b>14</b>
<b>IV</b>	<b>Collaborators and Responsibilities.....</b>	<b>15</b>
<b>V</b>	<b>Cost Estimates, Resources, and Support.....</b>	<b>16</b>
<b>1</b>	<b>Cost Estimates and Justification .....</b>	<b>16</b>
1.1	1998-1999 Budget.....	16
1.1.1	D. Equipment.....	16
1.1.2	E. Travel.....	16
1.1.3	G. Materials and Supplies .....	16
1.1.4	I. Indirect Costs.....	16
<b>VI</b>	<b>Appendix.....</b>	<b>17</b>
<b>1</b>	<b>List of Attachments.....</b>	<b>17</b>

# I Physics Goals

## 1 Overview

### 1.1 Introduction

## 2 Elastic Scattering at Small $|t|$

(Chunmei, Guryan, Rijssenbeek, Tepekian), CNI region, getting at sigma\_{tot}, rho, and the nuclear slope.  
Measurement techniques and pitfalls. Special tune.

### 2.1 Previous Experiments

ISR, SppbarS, Tevatron.

### 2.2 Theoretical Interest and Models

### 2.3 Polarization in the CNI Region

### 2.4 Experimentation with $pp$ at RHIC

#### 2.4.1 Machine Operation

RHIC pp luminosity, energy range, backgrounds, radiation environment.

#### 2.4.2 Simulations

Expected Precision on CNI Parameters

#### 2.4.3 Polarimeter Function

discussion of horizontal vs. vertical pots, rates

#### 2.4.4 Luminosity and Rates

## 3 Elastic Scattering at Medium $|t|$

(Chunmei, Penzo, Guryan)

### 3.1 Theoretical Interest and Models

### 3.2 Polarization at Medium $|t|$

### 3.3 Previous Experiments

### 3.4 Experimentation with pp at RHIC

#### 3.4.1 Machine Operation

RHIC pp luminosity, energy range, backgrounds, radiation environment.

#### 3.4.2 Simulations

results, etc.

#### 3.4.3 Backgrounds, Rates, and Luminosity

## **II Detectors**

### **1 Introduction**

roman pot history

### **2 Roman Pot System**

(Rijssenbeek)

#### **2.1 Machine Environment**

##### **2.1.1 Expected Signal Rates, Backgrounds, and Radiation**

##### **2.1.2 Requirements by the Accelerator**

Limitations on materials, vacuum demands, baking and outgassing from the accelerator.

##### **2.1.3 Vacuum Techniques and Materials**

##### **2.1.4 Beam-Induced RF in Detectors**

#### **2.2 Detector Requirements**

Positioning accuracy, absolute and relative. Repeatability.

#### **2.3 Detector Positioning**

##### **2.3.1 Local Position Determination**

##### **2.3.2 Global Positioning in the Accelerator**

##### **2.3.3 On-line Position Monitoring**

#### **2.4 RP Vacuum System**

##### **2.4.1 Description of System**

##### **2.4.2 Failure Modes and Protection**

## **3 Silicon Detectors**

(Lynn

### **3.1 Motivation and Requirements**

#### **3.1.1 Accuracy Requirements**

#### **3.1.2 Rate requirements**

#### **3.1.3 Radiation Hardness**

Maximum allowable rates.

### **3.2 Strip Detectors**

#### **3.2.1 Layout**

Layout and masks. Various components on the detector and their parameters.

#### **3.2.2 Strip Detector Performance**

Maximum rates, occupancy, degradation.

#### **3.2.3 Detector Supports**

#### **3.2.4 Position Accuracy**

#### **3.2.5 Specifications**

#### **3.2.6 Bench Tests and Acceptance Criteria**

### **3.3 SVX Read-out**

#### **3.3.1 Specifications, Timings, and Operation**

#### **3.3.2 Board Layout**

#### **3.3.3 Tests**

## **4 RP Trigger Detector**

(xxxxxx)

## 4.1 Trigger Strategy

### 4.2 Requirements

efficiency, acceptance, uniformity. Position accuracy.

#### 4.2.1 Rates and Deadtime

#### 4.2.2 Radiation Hardness

## 4.3 Design

### 4.3.1 Mechanical Layout

### 4.3.2 Lightguides

### 4.3.3 Photodetectors

## 4.4 Trigger

### 4.4.1 Trigger Electronics

### 4.4.2 Trigger Control

### 4.4.3

### 4.4.4

## 5 Detector Package

## 5.1 Trigger and Tracking Block

5.1.1 Design

5.1.2 Detector Platform Mounts

5.1.3 Vacuum and Leak Considerations

## 5.2 Package Positioning

5.2.1 In-Vacuum Accuracy

# 6 Central Region Detector

(Nurushev et al.)

## 6.1 Function of a Central Detector

In the medium  $t$  regime, standard tune.

## 6.2 CD Design Parameters

## 6.3 Connections to Brahms at Medium $|t|$

6.3.1 Trigger Feeds from and to Brahms

6.3.2 Common Data Stream

# 7 Data Acquisition

(xxxxx)

## 7.1 Overview and Philosophy

## 7.2 Read-out

### 7.2.1 SVX Read-out Board

### 7.2.2 Interface and Port Card

### 7.2.3 VME Front-End Buffer Board

## 7.3 SVX and VFB Control

## 7.4 On-line Computer

### 7.4.1 Data Transfer Control

### 7.4.2 On-line Preprocessing

### 7.4.3 On-line Data Monitoring and Fault Detection

## 7.5 Pulseheight Calibrations

### 7.5.1 Trigger Calibration

### 7.5.2 Silicon Detector Calibrations

## **8 Detector Position Control and Monitoring**

## 8.1 Pot Position Control

### 8.1.1 Pot Position Read-out

### 8.1.2 Detector Position Read-out

### 8.1.3 Failsafes

## 8.2 Beam Position Monitoring

## **9 Rate Monitoring**

## 9.1 Rate Monitoring

9.1.1 Maximum Allowable Rates and Protection Mechanisms

## **10 Data Analysis**

(xxxxx)

10.1 Data Streams

10.2 Data Storage

10.3 Data Base

10.3.1 Run Parameters

10.3.2 Machine Parameters

10.4 Reconstruction

10.4.1 Trajectory Tracing from IP to RP

10.4.2 Small  $|t|$  Data

10.4.3 Medium  $|t|$  Data

10.5 Systematics

10.5.1 Detector Position Calibration

10.5.2 Calibration of  $|t|$ -Scale

10.5.3 Acceptance and Efficiency Determination

10.5.4 Determination of Backgrounds

10.5.5 Systematics in the Analyzing Power  $A_N$

## 11 Prototypes and Tests

11.1 1998 Beam Test

11.1.1 Prototype Roman Pot System

11.1.2 Prototype Silicon Detector

11.1.3 Prototype Trigger and Detector Block

11.1.4 Prototype Readout System

## 11.2 Further Prototypes

### **III RHIC Run Requests**

## **IV Collaborators and Responsibilities**

# **V Cost Estimates, Resources, and Support**

## **1 Cost Estimates and Justification**

### **1.1 1998-1999 Budget**

- 1.1.1 D. Equipment**
- 1.1.2 E. Travel**
- 1.1.3 G. Materials and Supplies**
- 1.1.4 I. Indirect Costs**

## **VI Appendix**

### **1 List of Attachments**

PP2PP Proposal

References.

pp2pp\_proposal

W. Guryan et al., "Experiment to Measure Total and Elastic pp Cross Sections at RHIC", Proposal to the BNL-RHIC PAC, Updated version, September 1995.